Title of the Invention

Golf club head

Background of the invention

The present invention relates to a golf club head, more particularly to a structure of a weight member and socket therefor.

In the golf club heads, a weight member separate from the main body of the club head is often used in order to obtain desired weight distributions to adjust the gravity point, sweet spot, moment of inertia and the like of the head for example.

In case of metal wood-type hollow club heads, on the other hand, light-weight, strong metal materials such as titanium alloys are widely used in recent years. The use of such materials can decrease the wall thickness of the head. Therefore, if a large-sized, heavy weight member can be used in a club head whose wall thickness is relatively thin, then the design freedom will be remarkably increased.

In the laid-open Japanese patent application P2001-276287A, a method of securing a weight member to the head main body is disclosed, wherein, as shown in Figs.14(a) and 14(b), a cylindrical weight member (c) is put in a cylindrical socket (e), protruding its smaller diameter end portion (c2) from the inner end (e1) of the socket through a smaller diameter opening formed at the inner end (e1) of the socket. The protruding portion (c2) is pressed to deform, expanding over the surface of the inner end (e1) of the socket. In order to facilitate such deformation, the end of the protruding portion (c2) is provided with a hollow (c3).

when the size of the weight member is increased, the press force necessary to deform as above increases at an accelerating pace. Therefore, in this method, near the root of the socket as indicated by circles in Fig.14(b), the wall (a) is subjected to a large stress due to the large compressive stress transferred by the socket as indicated by arrows, which results in unfavorable residual stress or strain or, in the worst case, cracks in the finished article.

Summary of the Invention

It is therefore, an object of the present invention to provide a golf club head, in which, even if the size of the weight member is relatively large, the weight member is firmly and easily secured to the head main body without the above-mentioned drawbacks, and thereby the design freedom is greatly increased.

According to one aspect of the present invention, a golf club head comprises

a main body provided with a socket, and

a weight member disposed in the socket, wherein

the socket is a tubular portion extending towards the inside of the main body and having a through-hole extending therethough,

the weight member comprises a main portion accommodated to the through-hole, and the weight member is secured in the through-hole by crushing a crush portion, which is formed at the inner end of the main portion within the region of the inner end to protrude from the inner end of the socket, into the main

portion so that the main portion expands, pressing on the surface of the through-hole.

Brief Description of the Drawings

Fig.1 is a cross sectional view of a wood-type club head according to the present invention taken along line A-A of Fig.2.

Fig.2 is a bottom view thereof.

Fig.3 is an exploded perspective view of the head showing an exemplary two-piece structure comprising a hollow main part and a platy part to which a weight member is attached.

Fig.4 is an enlarged perspective view showing a weight member with a crush portion and a socket therefor.

Figs.5 and 6 are cross sectional views each showing another example of the crush portion.

Figs.7(a) and 7(b) are cross sectional views of the weight member put in the socket showing the states before and after the crush portion is crushed.

Figs.8(a) and 8(b) are plan views of the weight member for explaining various dimensions of the main portion and crush portion.

Fig.9 is a cross sectional view showing another example of the weight member.

Fig.10 is a cross sectional view showing another example of the weight member and socket therefor.

Fig.11 is a cross sectional view showing still another example of the socket.

Figs.12 and 13 are cross sectional views each showing a weight member used in the undermentioned comparison test.

Figs.14(a) and 14(b) show a prior art.

Description of the Preferred Embodiments

In Figs.1, 2 and 3, an embodiment of the present invention is a metal wood-type hollow golf club head 1 for a fairway wood.

The wood-type golf club head 1 comprises a face portion 2 whose front face defines a club face for striking a ball, a crown portion 3 intersecting the club face at the upper edge thereof, a sole portion 4 intersecting the club face at the lower edge thereof, a side portion 5 between the crown portion 3 and sole portion 4 which extends from a toe-side edge 2t to a heel-side edge 2h of the club face through the back face of the club head, and a neck portion 6 to be attached to an end of a club shaft (not shown), the neck portion 6 provided on the top thereof with an opening of a shaft inserting hole 6a for the club shaft.

The hollow (i) of the head 1 is void in this embodiment, but it is also possible to dispose a filler made of a resin, elastomer or the like in a form of solid or foam.

According to the present invention, the club head 1 comprises a main body and a weight member 1b. In this embodiment, the club head 1 comprises a hollow main part 1a2 having an opening O, a platy part 1a1 welded thereto so as to close the opening O, and a weight member 1b attached to the platy part 1a1, whereby the main body is made up of the hollow main part 1a2 and platy part 1a1.

Fig.3 shows an example of such structure. In this example, in order to make the center of gravity of the head lower and deeper, the weight member 1b is disposed in the sole portion 4. The opening O is formed at the bottom of the hollow main part 1a2, and the platy part 1a1 is welded to the bottom of the main part 1a2. The platy part 1a1 in this example forms the almost

entirety of the sole portion 4 (thus hereinafter, the "sole plate"). The hollow main part 1a2, accordingly forms the remaining portions, namely, the face portion 2, crown portion 3, side portion 5 and neck portion 6. As shown in Fig.1, at the weld J, two parts 1a1 and 1a2 are butt welded.

To make the main part 1a2 and platy part 1a1, various metal materials such as titanium alloys, aluminum alloys, stainless steel, steel the like can be used. Further, it is also possible to use a fiber reinforced resin to form a part of the head 1. In this embodiment, each of the hollow main part 1a2 and platy part 1a1 is made of a titanium alloy using a lost wax precision casting method. By the way, depending on the material, shape, region of the part to be formed, another method, e.g. forging, press molding and the like may be also employed.

In order to secure the weight member 1b, a socket 7 into which the weight member 1b fits is integrally formed on the platy part 1a1 (in this embodiment, on the sole portion 4 at a position biased towards the back end thereof).

The socket 7 is a tubular portion having a substantially constant wall thickness and protruding from the inner surface of the platy part 1a1 or the inner surface of the head to the hollow (i). The socket 7 has a through-hole 8 having an opening to the inside (i) of the head 1 and an opening to the outside of the head.

Figs.2, 3, 4 and 5 show an example of the socket 7. In this example, the through-hole 8 has a generally rectangular cross sectional shape whose corners are rounded, and the cross sectional shape is substantially constant throughout the depthwise direction. Aside from such a rectangle, various shapes,

e.g. a square with rounded corners, circle, oval, triangle with rounded corners, and the like can be used.

On the other hand, the weight member 1b is made of a plastically deformable relatively heavy material M. For example, tungsten, tungsten alloy, copper, copper alloy, brass, stainless steel and the like can be used. Usually, a metal material whose specific gravity is larger than the platy part 1a1 and main part 1a2 is used. Especially, a tungsten-nickel alloy is preferably used. The specific gravity is preferably in the range of from 8 to 20, more preferably about 12 to about 18.

The weight member 1b is provided at the inner end of its main portion 10 with a crush portion 11.

The main portion 10 has a cross sectional shape which is almost same but slightly smaller than that of the through-hole 8 so as to snug fit the through-hole 8. For the socket 7 shown in Fig.4, therefore, a rectangle with rounded corners is used as the cross section shape of the main portion 10.
The depth H of the main portion 10 is the same as or slightly larger (but very small as compared with "h") than the depth Ha of the through-hole 8, namely, the depth H is the substantially same as the depth Ha.

The crush portion 11 is a protrusion formed at the inner end 12 of the main portion 10 and tapering towards its end. Around the crush portion 11, a flat surface 14 remains while defining the inner end 12.

Fig.4 shows an example of the crush portion 11, which has a trapezoidal cross sectional shape in almost any cross section which is parallel with the depthwise direction (H) of the weight member 1b from the outer end 15 to the inner end 12. Thus, in

this example, the top surface 11b of the crush portion 11 is substantially flat and parallel with the above-mentioned flat surface 14.

Further, in any cross section which is perpendicular to the depthwise direction, the crush portion 11 has a similar figure to the contour of the main portion 10 at the inner end 12 which figure becomes smaller from its basal plane at the end 12 to the top surface 11b. Thus, in this particular case where the contour is a rectangle, the top surface 11b is also a rectangle, and the crush portion 11 has four side faces 11a inclined towards the center of the weight member 1b at an angle of from 40 to 60 degrees with respect to the flat surface 14.

Aside from the trapezoidal cross sectional shape where the top surface is flat, another shape where the top surface is slightly swelled may be used as well. Fig.5 shows an example of such shape which is defined by a comparatively flat arc, e.g. a part of ellipse, a part of circle and the like.
Further, as shown in Fig.6, a comparatively flat triangular shape such as isosceles triangle may be used as far as the central region is higher than the peripheral region (14).
When the cross sectional shape of the main portion 10 of the weight member 1b is a rectangle, oval or the like, the crush portion 11 may be formed to have such a cross sectional shape along the direction parallel with the long sides or major axis of the cross sectional shape of the main portion.

The weight member 1b is, as shown in Fig.7(a), put into the socket 7 of the platy part (sole plate) 1a1. The platy part 1a1 is put on a mold 17 to hold the platy part 1a1 while keeping

the weight member 1b in its place such that the outer end or surface 15 of the main portion 10 aligns with the outer surface F of the platy part 1a1. Then, as shown in Fig.7(b), using a press die P, the crush portion 11 is crushed towards the main portion 10 as indicated by arrows. At that time, owing to the opening of the through-hole 8 at the surface F, the mold 17 can support and press the outer end 15 towards the counter direction. In this example, the entire volume is crushed into the main portion 10 so as to become flat with the inner end of the socket 7.
As the weight member 1b crushed in the through-hole 8 expands radially near the inner end 12, the through-hole 8 is radially expanded accordingly such that the expansion becomes larger towards the end of the tubular portion, whereby the end of the tubular portion flares and the weight member 1b is tightly locked. Then, the assembly of the platy part 1a1 and weight member 1b is welded to the main part 1a2 to form the head 1.

It is preferable that the expansion Wb-Wa at the inner end 12 is more than 0.3 mm, but not more than 0.6 mm. More definitely, when the dimension is measured, before the crush portion 11 is crushed, across the contour shape of the inner end 12 of the weight member 1b, passing the centroid Sg1 of the contour shape in every direction around the centroid Sg1, the minimum Wa thereof shows a difference (Wb-Wa) of not less than 0.3 mm but not more than 0.6 mm from the dimension Wb measured in the same direction across the deformed contour shape after the crush portion 11 is crushed.

To achieve the desired radial expansion, the protruding height h of the crush portion 11 from the inner end 12 is set in the range of from 0.5 to 1.5 mm. If the height h is more than

1.5 mm, it becomes difficult to radially expand the main portion from a suitable deep position and as a result, the flared part becomes shorter which results in the reduced engage force, OR a fracture is liable to occur at the end of the socket because a extremely larg crushing force is required. If the height h is less than 0.5 mm, it is difficult to obtain the desired sufficient engaging force.

On the other hand, if the above-mentioned flat surface 14 around the crush portion 11 is too narrow in width, fracture is liable to occur at the end of the socket. If the width is too wide, it becomes difficult to obtain the necessary expansion. Therefore, it is preferable that the width of the flat surface 14 is not less than 0.8 mm, preferably not less than 1.5 mm, but not more than 2.5 mm, preferably not more than 2.0 mm.

Further, if the wall thickness of the socket 7 is too small, fracture is liable to occur at the end of the socket. If too large, it becomes difficult to obtain the appropriate flared part. Although the desirable range somewhat varies depending on the material, it is preferable that the wall thickness of the socket 7 is set in a range of from about 1.5 to about 3.0 mm.

Given that average width W3 of the inner end 12 is the average of dimensions (W3a, W3b, W3c --) which are, as shown in Fig.8(a), measured across the shape of the inner end 12, passing through the centroid Sg1 of the shape, every predetermined small angle (for example 10 degrees) around the centroid Sg1, the ratio (W3/h) of the average width W3 to the above-mentioned height h is preferably set in the range of from 7 to 20, more preferably 9 to 15.

Further, similarly to the width W3, when the average width

W2 of the basal plane of the crush portion 11 is defined as the average of dimensions (W2a, W2b, W2c --) which are, as shown in Fig.8(b), measured across the shape of the basal plane, passing through the centroid Sg2 of the shape, every predetermined small angle (for example 10 degrees) around the centroid Sg2, the ratio (W2/W1) of the average width W2 to the average W1 of widths (W1a, W1b, W1c --) of the flat surface 14 is preferably set in the range of 5 to 9, more preferably 6 to 8.

Fig.9 shows a modification of the above-mentioned weight member 1b, wherein a crush portion 11 is formed at the outer end 15 in addition to the inner end 12 so as to form a flared part on each side of the weight member 1b. In this case, it is preferable that the through-hole 8 is provided at the outer end with a gradually expanded part 8b in advance.

Fig.10 shows a further modification of the above-mentioned weight member 1b, wherein to facilitate the positioning of the weight member, a flange 10b is provided at the outer end 15 of the main portion 10. The through-hole 8 is accordingly, provided immediately inside the outer end with a stepped expanded part 8b. The expanded part 8b is shaped to accommodate the flange 10b so as to make these surfaces flat.

Fig.11 shows a modification of the above-mentioned through-hole 8, wherein, in order to increase the engaging force between the weight member 1b and socket 7, the inner surface of the through-hole 8 is provided with a continuously or discontinuously extending circumferential groove 8g. The position of the circumferential groove 8g is set in the flaring part at a small distance from the end of the hole.

In stead of discontinuous groove 8g, it is also possible to

provide a plurality of holes or dents arranged circumferentially at small intervals.
The depth of the groove, dent or hole is set in the range of 0.5 to 1.5 mm.

Comparison Tests

Several kinds of weight members were made, changing the crush portion only as shown in Table 1. The main portion 10 had, as shown in Fig.4, a 19.9X4.9mm rectangular cross sectional shape whose corners were rounded by a radius R of 0.5mm, and a depth H of 6 mm. The material of the weight member was a tungsten-nickel alloy having a specific gravity of 14.5.

Using those weight members in combination with the sole plate 1a1 shown in Figs.3, the weight member was put in the socket and, by crashing the crush portion as explained above, they were fixed to each other. The socket was formed on the sole plate 1a1 and as shown in Fig.4, the through-hole had a depth Ha of 6 mm and a 20X5mm rectangular cross sectional shape whose corners were rounded by a radius R of 0.5mm accommodating to the main portion of the weight member.

50 pieces of such assembly were made with respect to each of the weight members.
The flared end portion of the socket was checked for fracture.
The percentage of occurrence of fracture is shown in Table 1.
The engaging force between the weight member and socket was measured as a force at which the weight member starts to move relatively to the socket when the inner end of the weight member was pushed towards the outer end. The measured force is indicated by an index based on Ex.1 being 100. The larger the

index number, the larger the engaging force.

Table 1

Weight member	Ex.1	Ex.2	Ex.3	Ex.4	Ex.5	Ref.1	Ref.2
Crush portion	Fig.4	Fig.4	Fig.4	Fig.4	Fig.4	Fig.12	Fig.13
h (mm)	0.5	0.2	1.5	0.5	0.5	1.0	1.0
W3 (mm)	10	10	10	10	10	10	10
W3/h	20	50	6.7	20	20	10	10
W1 (mm)	1.0	1.0	1.0	0.5	2.0	10	1.0
W2 (mm)	8.0	8.0	8.0	9	6.0	10	—
W2/W1	8.0	8.0	8.0	18	3.0	1.0	—
Engaging force	100	53	100	73	53	33	50
Fracture (%)	0.5	0.5	1.4	1.3	0.5	1.5	2

As apparent from the test results, in comparison with Ref.1 and Ref.2, Ex.1-Ex.5 were decreased in the occurrence of fracture and increased in the engaging force.
In addition, as the weight member can fit tightly to the socket by its radial expansion, the weight member was not required to have high accuracy. Therefore, the production efficiency may be greatly improved and also the production cost may be reduced.

In the above-mentioned embodiment, the weight member 1b is disposed in the sole portion 4. But, the weight member 1b may be disposed in another portion such as the side portion 5 and crown portion 3.

The present invention is suitably applied to a metal wood-type hollow golf club head as described above. But, it can be also applied to other types such as iron-type, patter-type and utility-type.